

CLAIMS

1. Assembled particles of a plant virus containing a predetermined foreign peptide as part of the coat protein of the virus.
2. Virus particles according to claim 1, in which the foreign peptide is a biologically functional peptide, the biological application of which requires or is enhanced by presentation of the peptide in association with a larger molecule or particle.
3. Assembled particles of a plant virus containing a foreign peptide insert in the coat protein of the virus, the site of the insert being free from direct sequence repeats flanking the insert.
4. Virus particles according to claim 3, in which the insert is an addition to the coat protein.
5. Virus particles according to claim 3, in which the foreign peptide is a biologically functional peptide, the biological application of which requires or is enhanced by presentation of the peptide in association with a larger molecule or particle.
6. Virus particles according to claim 1, in which the peptide is an antigen.
7. Virus particles according to claim 6, in which the antigen is a viral antigen.
8. Virus particles according to claim 7, in which the antigen is an animal (including human) viral antigen.
9. Virus particles according to claim 1, in which the foreign peptide is incorporated in an exposed surface of the coat protein of the plant virus.
10. Virus particles according to claim 1, wherein the plant virus is an RNA virus.

11. Virus particles according to claim 1, wherein the viral coat protein has a β -barrel structure.

12. Virus particles according to claim 11, wherein the foreign peptide is inserted in a loop connecting β sheets of the plant virus.

13. Virus particles according to claim 12, wherein the foreign peptide is inserted next to a proline or hydroxyproline residue in a loop connecting β sheets of the plant virus.

14. Virus particles according to claim 1, in which the plant virus is a member of a virus family selected from ¹*Caulimoviridae*, ²*Bromoviridae*, ³*Comoviridae*, ⁴*Geminiviridae*, ⁵*Reoviridae*, ⁶*Partitiviridae*, ⁷*Sequiviridae*, ⁸*Tombusviridae*; a member of a virus genus selected from *Luteovirus*, *Marafivirus*, *Sobemovirus*, *Tymovirus*, *Enamovirus* and *Idaeovirus*; or a rod-shaped plant virus selected from the following: ¹⁰*Tobamovirus*, ¹¹*Tobravirus*, ¹²*Hordeivirus*, ¹³*Furovirus*, ¹⁴*Potexvirus*, ¹⁵*Capillovirus*, ¹⁶*Trichovirus*, ¹⁷*Carlavirus*, ¹⁸*Closterovirus* and ¹⁹*Potyvirus*.

15. Virus particles according to claim 1, in which the plant virus is a Comovirus.

16. Virus particles according to claim 15, in which the Comovirus is a cowpea mosaic virus (CPMV).

17. Virus particles according to claim 12, in which the foreign peptide is inserted in the $\beta\beta$ - $\beta\gamma$ loop of the plant virus.

18. Virus particles according to claim 12, in which the inserted foreign peptide is a replacement of part of the existing loop.

19. Virus particles according to claim 12, in which the inserted foreign peptide is an addition to the existing loop.

20. Virus particles according to claim 1, in which the foreign peptide is an animal virus antigen derived from foot and mouth disease virus (FMDV).
21. Virus particles according to claim 1, in which the foreign peptide is an animal virus antigen derived from human immune deficiency virus (HIV).
22. Virus particles according to claim 1, in which the foreign peptide is an animal virus antigen derived from a human rhinovirus (HRV).
23. Virus particles according to claim 1, in which the foreign peptide is an animal virus antigen derived from canine parvovirus.
24. Virus particles according to claim 1, in which the foreign peptide is an animal pathogen antigen derived from *Staphylococcus aureus*.
25. Virus particles according to claim 1, in which the foreign peptide is an antigen derived from a peptide hormone.
26. Virus particles according to claim 25 in which the foreign peptide is an antigen derived from gonadotrophin releasing hormone.
27. Virus particles according to claim 1, in which the foreign peptide is an antigen derived from human polythiopine epithelial cell mucin.
28. An antigenic complex comprising plant virus particles as defined in claim 1 as an immunogenic component thereof.
29. An antigenic complex comprising virus particles as defined in claim 8.

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31. A method according to claim 30, in which the plant viral nucleic acid is RNA, and infection is carried out with DNA corresponding to the modified viral RNA.

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32. A method for producing plant virus particles according to claim 3, which comprises introducing a nucleotide sequence coding for a foreign peptide to modify the plant viral nucleic acid which codes for the coat protein in such a way as to avoid the production of direct sequence repeats flanking the introduced sequence, infecting plants, plant tissue, plant cells, or protoplasts with the modified viral nucleic acid, and harvesting assembled particles of the modified virus.

33. A method according to claim 30, in which the introduced nucleotide sequence is inserted in that part of the plant viral nucleic acid which codes for an exposed portion of the coat protein.

34. A method according to claim 30, applied to an RNA plant virus, which comprises introducing a DNA sequence coding for the foreign peptide into a cDNA corresponding to the RNA of the plant virus which codes for an exposed portion of its coat protein, producing from the thus modified cDNA an RNA transcript thereof, inoculating plants, plant tissue, plant cells, or protoplasts with the transcript, if necessary together with any other RNA required for multiplication and assembly of whole virus particles in the plant material, and harvesting assembled particles of the modified virus.

35. A method according to claim 34, in which the cDNA is produced by introducing the DNA encoding the foreign peptide into a DNA fragment excised from the plant viral cDNA, and recombining the modified fragment so as to reconstitute the plant viral cDNA in modified form.

36. A method according to claim 32, in which the foreign nucleotide sequence is inserted by selecting two different restriction enzyme sites in the plant viral nucleic acid; cutting the plant viral nucleic acid using the corresponding restriction enzymes; and inserting into the cut viral nucleic acid a pair of complementary oligonucleotides which encode the foreign peptide and which terminate in ends compatible with the restriction enzyme cutting sites.

37. A method according to claim 36, in which in the complementary oligonucleotides, the sequence encoding the foreign peptide is flanked by plant virus-specific sequences so that the foreign nucleotide sequence is inserted as an addition to the plant viral nucleic acid.

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38. A method according to claim 34, in which modified virus produced, or RNA extracted therefrom, is passaged in plants to produce further yields of modified virus.

39. A method according to claim 30, in which the cDNA contains a cauliflower mosaic virus 35S promotor sequence linked to the 5' end of the construct.

40. A fragment of CPMV coat protein cDNA containing a DNA sequence encoding a foreign peptide at a site corresponding to an exposed surface of the coat protein.

41. A fragment of CPMV coat protein cDNA according to claim 40, the site being free from direct sequence repeats flanking the DNA insert.

42. A fragment according to claim 39, being an Sst1 fragment.

43. A vector containing a fragment according to claim 40.

44. A vector comprising a full length cDNA of CPMV M RNA containing a DNA insert encoding the foreign peptide at a site corresponding to an exposed surface of the coat protein.

45. A vector according to claim 44, the site being free from direct sequence repeats flanking the DNA insert.

101 80W 46. An RNA transcript of a fragment or vector according to claim 41.

47. A capped RNA transcript according to claim 46.

48. A method of protecting animals (including humans) against pathogens which comprises administering an antigenic complex according to claim 28.